U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-252 670

# RADIATION SURVEY IN BEATTY, NEVADA, AND SURROUNDING AREA (MARCH 1976)

OFFICE OF RADIATION PROGRAMS

APRIL 1976

141007

PB 252 670

Technical Note
ORP/LV-76-1

# RADIATION SURVEY IN BEATTY, NEVADA, AND SURROUNDING AREA (MARCH 1976)

APRIL 1976

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS
LAS VEGAS FACILITY
LAS VEGAS, NEVADA 89114

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

**TECHNICAL REPORT DATA**
*(Please read Instructions on the reverse before completing)*

| | |
|---|---|
| 1. REPORT NO. ORP/LV-76-1 | 2. |
| 3. RECIPIENT'S ACCESSION NO. | |
| 4. TITLE AND SUBTITLE<br>Radiation Survey in Beatty, Nevada, and Surrounding Area (March 1976) | 5. REPORT DATE<br>April 1976 |
| | 6. PERFORMING ORGANIZATION CODE |
| 7. AUTHOR(S)<br>D. W. Hendricks and C. W. Fort, Jr. | 8. PERFORMING ORGANIZATION REPORT NO. |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Office of Radiation Programs--Las Vegas Facility<br>U.S. Environmental Protection Agency<br>P.O. Box 15027<br>Las Vegas, NV 89114 | 10. PROGRAM ELEMENT NO.<br>11. CONTRACT/GRANT NO. |
| 12. SPONSORING AGENCY NAME AND ADDRESS | 13. TYPE OF REPORT AND PERIOD COVERED<br>Final<br>14. SPONSORING AGENCY CODE |

15. SUPPLEMENTARY NOTES

16. ABSTRACT

At the request of the State of Nevada, a radiation survey was initiated in the Beatty, Nevada, area on March 10, 1976, to identify and locate radioactive materials which might have been removed from the Nuclear Engineering Company low-level radioactive waste burial site located near Beatty. Approximately 280 locations including dwellings, storehouses, schools, saloons, hotels, motels, businesses, ranches, and mines were inspected. Seventeen residences in Beatty and the surrounding area were identified where the sole radioactive items found were radium-dial clocks, compasses, and instrument gauges which had been distributed from the burial site. An additional 25 locations were identified where other radioactive items originating from the Beatty site were found. Subsequent to the Beatty survey, additional items removed from the Beatty burial site were identified in Pahrump, Nevada, and in the Amargosa, Nevada, farm area. Levels of radon gas released from two military clocks and one military wrist compass were measured at the Office of Radiation Programs--Las Vegas Facility for dose estimation. Radiation exposures to persons possessing the various radioactive materials appear to have been generally and fortuitously minimal.

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| Radioactive Wastes | Beatty, Nevada | 1807 |
| Waste Disposal | Radium-dial Instruments | 1807 |
| Radiological Contamination | Radiation Survey | 1808 |
| | Radon Measurements | |

PRICES SUBJECT TO CHANGE

| | | |
|---|---|---|
| 18. DISTRIBUTION STATEMENT<br>Release Unlimited | 19. SECURITY CLASS *(This Report)*<br>UNCLASSIFIED | 21. NO. OF PAGES<br>53 |
| | 20. SECURITY CLASS *(This page)*<br>UNCLASSIFIED | 22. PRICE<br>4.50-2.25 |

i.

EPA Form 2220-1 (9-73)

☆GPO 690-901-1976

Technical Note
ORP/LV-76-1

# RADIATION SURVEY IN BEATTY, NEVADA, AND SURROUNDING AREA (MARCH 1976)

D. W. Hendricks
C. W. Fort, Jr.

April 1976

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS
LAS VEGAS FACILITY
LAS VEGAS, NEVADA 89114

This report has been reviewed by the Office of Radiation Programs--Las Vegas Facility, U.S. Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for their use.

# PREFACE

The Office of Radiation Programs of the U.S. Environmental Protection Agency carries out a national program designed to evaluate population exposure to ionizing and non-ionizing radiation and to promote development of controls necessary to protect the public health and safety.

Within the Office of Radiation Programs, the Las Vegas Facility conducts in-depth field studies of various radiation sources (e.g., nuclear facilities, uranium mill tailings, and phosphate mills) to provide technical data for environmental impact statement reviews as well as needed information on source characteristics, environmental transport, critical pathways for population exposure, and dose model validation. The Office of Radiation Programs--Las Vegas Facility also provides, upon request, technical assistance to Western States and to other Federal agencies. In this technical assistance role, the Las Vegas Facility participated in a radiation survey in the Beatty, Nevada, area. The primary purpose of the survey was to determine if radioactive materials intended for burial at the Beatty, Nevada, commercial low-level radioactive waste burial site had been removed from the site and distributed in the nearby community. A secondary purpose was to identify these materials so that they might be returned to the burial site. This report summarizes the results of that survey which was conducted in March 1976.

Readers of this report are encouraged to inform the Office of Radiation Programs--Las Vegas Facility of any omissions or errors. Comments or requests for further information are also invited.

Donald W. Hendricks

Donald W. Hendricks
Director, Office of Radiation
Programs--Las Vegas Facility

CONTENTS


| | Page |
|---|---|
| PREFACE | iii |
| LIST OF FIGURES | v |
| ACKNOWLEDGMENTS | vi |
| STUDY PARTICIPANTS | vii |
| SUMMARY AND CONCLUSIONS | 1 |
| INTRODUCTION | 3 |
| SURVEY | 6 |
| General | 6 |
| Chronology and Highlights | 7 |
| DISCUSSION | 10 |
| APPENDIXES | |
| I Location and Identification of Radioactive Items Found During Beatty, Nevada, Survey--March 1976 | 12 |
| II Selected Photographs of Items Located During Beatty Survey | 25 |
| III Radium-Dial Clocks and Compass | 34 |
| IV Portable Survey Instruments Used in Beatty, Nevada Survey | 37 |

LIST OF FIGURES


| | | Page |
|---|---|---|
| APPENDIX I | | |
| Figure 1 | Figure Index of Areas Inspected for Radioactive Materials from the NECO Disposal Site--March 1976 | 20 |
| Figure 2 | Locations Inspected for Radioactive Materials--March 1976 | 21 |
| Figure 3 | Radioactive Materials Located in Beatty, Nevada--March 1976 | 22 |
| Figure 4 | Locations Inspected for Radioactive Materials--March 1976 | 23 |
| Figure 5 | Locations Inspected for Radioactive Materials--March 1976 | 24 |
| APPENDIX II | | |
| Figures 1-15 | Selected Photographs of Items Located During Beatty Survey | 26-33 |

## ACKNOWLEDGMENTS

The U.S. Environmental Protection Agency expresses grateful appreciation to the residents of Beatty, Nevada, and the surrounding area. Without their full and understanding cooperation, this effort would not have been possible. Special thanks go to Nye County Deputy Sheriffs Ron Korienek and Bert Gray and to Officer Brian Thayer, Nevada Highway Patrol.

## STUDY PARTICIPANTS

Representatives from several Federal agencies as well as State of Nevada officials and Federal agency contractors participated in the study. The following agencies and contractors participated to varying degrees in the study:

State of Nevada/Department of Human Resources
State of Nevada/Radiological Health Supervisor
State of Nevada/Department of Agriculture
State of Nevada/Highway Patrol
Nye County Nevada/Sheriff's Department
U.S. Environmental Protection Agency/Office of Radiation Programs--Las Vegas Facility
U.S. Environmental Protection Agency/Environmental Monitoring and Support Laboratory--Las Vegas/ Office of Research and Development
U.S. Environmental Protection Agency/Region IX
U.S. Nuclear Regulatory Commission/Regions III and V
U.S. Energy Research and Development Administration
Reynolds Electrical & Engineering Company, Inc.
EG&G, Inc.
Lawrence Livermore Laboratory, University of California

## SUMMARY AND CONCLUSIONS

For almost 13 years radioactive materials have been shipped to the Beatty, Nevada, Nuclear Engineering Company (NECO) burial site. All radioactive materials sent to the site were to have been buried under the terms of the site licenses. In actual fact, large quantities of radioactive materials sent to the site for burial were diverted from the site for private use.

Radiation surveys were conducted in Beatty, Nevada, and nearby areas by the U.S. Environmental Protection Agency (EPA), Office of Radiation Programs--Las Vegas Facility (ORP--LVF), EPA Environmental Monitoring and Support Laboratory--Las Vegas (EMSL--LV), and contractors of the Nevada Operations Office of the U.S. Energy Research and Development Administration (ERDA) which included: Reynolds Electrical and Engineering Co., Inc. (REECo), Lawrence Livermore Laboratories--University of California (LLL), and EG&G, Inc. (EG&G). Radioactive materials distributed from the Beatty, Nevada, commercial low-level radioactive waste burial site were found at a number of locations (see Appendix I). Concrete was found at several locations which contained low levels of gamma-emitting radionuclides. Contaminated soil was found at three locations. Radioactive contamination which could be removed by swiping was found at several locations. Containers used for shipping radioactive materials were found at numerous locations. Some metal containers and some wooden packing crates were radioactively contaminated. Bennett containers and other types of metal shipping containers were in use as septic tanks and as water tanks for both humans and livestock. Plywood from shipping crates was in widespread use in various types of structures.

At three locations items having unconfined or removable radioactivity were found in residences. In a number of homes the only radioactive items found were wall clocks, compasses, or gauges (all with radium-226 dials). In a few cases these items probably did not come from the burial site but still contained some quantity of radioactivity.

Isotopes identified by EPA, REECo, EG&G, and LLL included radium-226, cobalt-58, cobalt-60, manganese-54, cesium-137, strontium-90, plutonium-238, plutonium-239, uranium-235, uranium-238, antimony-125, silver-108m, silver-110m, chromium-51, carbon-14, tritium, and europium-155. The types of radioactive or contaminated materials (or materials identified as having passed through the burial site) include plywood, Bennett

containers (steel shipping containers), military clocks, compasses, gauges, balances, centrifuges, concrete slabs, carpet, electric motors, tools, interior walls of a radioactivity laboratory, toolboxes, drill pipe, wood, laboratory grinders, miscellaneous types of small shipping containers, sheets of magne-thor, and electrical switch boxes. (See Appendix II for photographs of selected materials found during the survey.)

Subsequent to the Beatty survey, additional items removed from the Beatty burial site were identified in Pahrump and Las Vegas, Nevada, and in the Amargosa, Nevada, farm area. While it was confirmed that radioactive items had been removed from the NECO site to areas beyond the Beatty vicinity, it was considered impractical to begin a systematic survey in these areas without more specific information. NRC is distributing a questionnaire to residents in other communities around the site in an effort to locate other missing materials.

Levels of radon gas released from two military clocks and one military wrist compass were measured at the LVF for purposes of dose estimation. Radon release levels from the individual instruments were found to be sufficiently low that in an average home the radon and radon progeny levels would probably be indistinguishable from natural background (assuming the instruments remain undamaged.) (See Appendix III.)

Based on data available at this time, it appears that there was no significant exposure to persons from the various radioactive materials found. However, there were many items which contained enough radioactive material to pose health hazards and to require major decontamination costs should the items have been broken open and the radioactive materials released to the environment. It should also be noted that there exists the possibility of higher exposures from radioactive materials at locations in areas not covered by the survey. Additionally, it is conceivable that short half-life radionuclides may have been initially present on materials at the time of removal from the site but could have subsequently decayed to non-detectable levels by the time of the survey.

## INTRODUCTION

In late 1962 the U.S. Atomic Energy Commission issued a license for burial of low-level radioactive wastes at a site located near Beatty, Nevada. Since that time low-level nuclear wastes have been disposed of at that site in a cut-and-cover trench operation, with individual trenches measuring approximately 20 to 40 feet deep, 40 to 90 feet wide, and up to 700 feet in length.

In 1972, the State of Nevada became an agreement state with the U.S. Nuclear Regulatory Commission (NRC) (formerly the U.S. Atomic Energy Commission) and accepted the responsibility for licensing and regulating the disposal of low-level radioactive wastes within the State, except for special nuclear material, which remains under the authority and responsibility of NRC. The Beatty burial site, operating under this agreement, is owned by the State of Nevada and is leased to NECO.

The Beatty burial site is located in Nye County (in southwestern Nevada, approximately 95 miles northwest of Las Vegas). The two nearest towns are Beatty (11 miles to the north) and Lathrop Wells (18 miles to the southeast). Both are small desert communities with populations less than 500.

During the last week of February 1976, the State of Nevada was advised by NECO that a concrete mixer truck from the Beatty burial site had been used to pour concrete slabs in the community of Beatty. (The truck was used at the site to mix low-level liquid radioactive waste with cement. The mixture was then poured into the bottom of the burial trenches for solidification since only solid wastes could be buried at the site.) The obvious concern was that the concrete slabs poured in Beatty might contain some residual contamination from the mixer truck.

As a result of this notification, the State of Nevada radiological health supervisor requested assistance from the ORP--LVF in monitoring the concrete slabs for possible radioactivity. One March 2, 1976, the State radiological health supervisor, the director, ORP--LVF, and a radiation technician from the EMSL--LV met with NECO employees at the NECO site. They were informed by the employees that at least three slabs in Beatty had been poured using the NECO mixing truck. The slabs were to be used as a foundation for a residence, a patio behind a saloon, and a floor for the town jail and courthouse building. A fourth slab, being used as the floor of a chicken

coop, had also possibly been poured using the same truck, but prior to initial use of the truck at the NECO site. Inspections of the slabs on March 2, using a Baird Atomic NE-148A Gamma Scintillator, revealed three spots with elevated radiation levels on the saloon slab (see Appendix IV for description of instrumentation). The saloon slab contact measurements (using an Eberline E-500B beta-gamma survey meter) on the three localized areas indicated levels of 45, 15, and 8 mrad/hr. beta plus gamma exposure rates respectively. The residence slab showed a slight gamma exposure rate (3-6 μr/hr.) above background with the contamination appearing to be relatively homogeneous. Gamma measurements of the courthouse slab were all background. No obvious gamma radiation levels above background were found at the chicken coop site using the scintillator survey meter.

At the residence foundation, samples of concrete, apparently left over from the pour, were picked up for laboratory analysis at EMSL--LV. Analysis by gamma spectroscopy indicated trace quantities of cobalt-58, cobalt-60, and manganese-54. An aliquot of a sample collected earlier by NECO at the same location was also analyzed by EMSL--LV. This sample also contained cobalt-58.

On March 4, 1976, NECO removed the concrete slab behind the saloon to the NECO burial site. Samples of the 45 mrad/hr. spot in the concrete were collected by the EMSL--LV radiation technician for analysis. Analysis indicates that there was a very localized concentration of cobalt-60 with the surrounding concrete containing trace quantities of cobalt-58, cobalt-60, and manganese-54. Leftover concrete pieces from the courthouse were also analyzed by EMSL--LV, but only background levels of radioactivity were detected. Concrete samples were not obtained at the chicken coop.

On March 4, 1976, the EMSL--LV radiation technician, at the request of the State radiological health supervisor, also collected soil and vegetation samples from four locations close to, but outside, the burial site boundaries. The vegetation sample collected 25 yards south of the site showed trace quantities of cobalt-58, cobalt-60, and manganese-54. Levels of radioactivity in the soil sample collected near the positive vegetation sample were so low that it was not certain if the soil sample contained radionuclides other than those from natural radioactivity and world-wide fallout. The other soil and vegetation samples had no detectable levels of artificial radionuclides above background. Resampling of vegetation in the area south of the site on March 9, 1976, confirmed the previous findings of trace quantities of cobalt-58, cobalt-60, and manganese-54 in vegetation. Soil samples collected during the resampling were also found to clearly contain trace quantities of the radionuclides found in the vegetation.

On March 8, 1976, the State of Nevada, through the State of Nevada radiological health supervisor and the State of Nevada director, Department of Human Resources, requested technical assistance from the ORP--LVF. The State had decided to conduct a door-to-door check for radioactivity in the Beatty community to determine if there were any factual basis in allegations which had been made to the effect that potentially contaminated materials (other than the concrete mixer truck) had been removed from the Beatty burial site. The technical assistance requested was to identify and locate during the door-to-door search radioactive materials in Beatty and surrounding areas which might have been removed from the Beatty site, and which might represent real or potential health hazards. Any objects identified would then be returned to the site for burial.

The State request was discussed by the director, ORP--LVF, with the Office of Radiation Programs (Headquarters), with EPA Region IX radiation representative, and with the director, EMSL--LV. The director, EMSL--LV, in turn, coordinated the request with ERDA.

Approval from Region IX and ORP (Headquarters) was given for ORP--LVF to participate with the clear understanding that the EPA role was solely to provide assistance to the State. On March 9, 1976, the State of Nevada radiological health supervisor met in Las Vegas with the director, ORP--LVF, and a member of the LVF staff to discuss details of the proposed door-to-door search. The director of the EMSL--LV Information Services Staff and one staff member also participated in this meeting. As a result of this meeting and a number of telephone discussions, it was agreed that the search would get underway on the following day (March 10, 1976) in Beatty, Nevada. The initial participants in the program would be the State of Nevada director, Department of Human Resources, the State of Nevada radiological health supervisor, the director, ORP--LVF, four LVF staff members (serving as radiation monitors), and three EMSL--LV radiation technicians (also serving as monitors). The EMSL--LV technicians were available only on a non-interference basis since their primary mission in the Beatty area was in support of the Nevada Test Site off-site monitoring program for two nuclear tests which were scheduled during the week of March 8, 1976. It was agreed that an LVF staff member would serve as project coordinator to assure that all possible locations were monitored. EPA personnel were individually provided with identification certifying that they were representing the State of Nevada in the investigation.

## SURVEY

### GENERAL

On the morning of March 10, 1976, a meeting was held in Beatty, Nevada, between personnel from the State of Nevada, EPA, and the NRC to discuss all aspects of the door-to-door survey. Pertinent information regarding types of materials known to have been taken offsite was discussed to aid the EPA radiation monitoring personnel in their search. Maps of Beatty, copied from aerial photographs taken by the Remote Sensing Division, EMSL--LV, were distributed to each EPA monitor. The town was divided into four quadrants, with two monitors being assigned to each of two quadrants. Monitors generally worked individually at residences to allow an owner, in cases where only one resident was at home, to accompany then throughout their home and exterior property. The survey began at about 1 p.m., March 10, 1976. Surveys continued each day until dusk and began on the days after March 10, at 8 a.m. On Sunday, March 14, 1976, continuing surveys of private residences began at about 10:30 a.m. to minimize disturbing late sleepers.

Each monitor was equipped with a fast response gamma detector (Baird-Atomic NE-148A Scintillator) for the walk-through survey. Alpha detection equipment was also available as a secondary search instrument but was used only in suspect situations because of time considerations.

The interview of various individuals by State and NRC investigators revealed information regarding additional specific items known to have been taken from the burial site. The monitors were advised, as this information became known, to allow them to be more specific in their search.

Arrangements were made by the State personnel with NECO personnel to provide retrieval of all items located during the search. The radiation monitors were advised to note the locations of items for referral to NECO for pickup. However, there were a few instances where individuals requested monitors to take possession of items they had located rather than wait for NECO personnel to pick the items up. Items collected in this fashion were stockpiled and turned over to NECO on a daily basis. Items identified but left at residences were reported to NECO personnel who then retrieved them.

Additional items were brought to monitors or NECO personnel, turned in at the town meeting, or placed in NECO trucks by anonymous citizens. Because of the truck load quantities of materials recovered during the survey, no attempt was made to keep a comprehensive list of individual items or to make extensive measurements on each item. The primary goal was to locate and return the materials. Appendix I, therefore, lists locations identified as having radioactive materials and lists some of the more representative items found at the particular location. Individual locations are identified on the accompanying maps (Figures 1-5). In some instances it is known that ownership was at least once removed from the original source. This fact was illustrated when a resident, just moving into a recently purchased home, requested an EPA monitor to remove a radium-dial military wall clock (left by the prior owners) from the residence.

## CHRONOLOGY AND HIGHLIGHTS

During the first afternoon of the survey, a triple beam laboratory balance was located in a residence as a result of the gamma search. Alpha monitoring of the balance revealed positive and removable alpha contamination. A smear test of the balance was sent to the EMSL--LV laboratory, and on Friday morning, March 12, 1976, was identified as containing plutonium-239.

By Thursday evening, March 11, approximately 50 per cent of the residences and businesses in Beatty and ranches in outlying areas had been surveyed. During this time a number of radium-dial clocks, compasses, and gauges had been located, in addition to externally contaminated items such as plywood, sample mixers, a centrifuge, and lead bricks. Non-contaminated items (of NECO origin) such as Bennett containers (6 ft. diameter by 7 ft. high steel drums with bolt down lids used as radioactive waste shipping containers) and plywood, marked "L.S.A." (low specific activity) were also found. Because of the findings on March 10, two additional ORP--LVF staff members arrived on March 11, 1976, to assist in the search. Also on March 11, 1976, the NRC requested ERDA to provide additional assistance to monitor for special nuclear material.

On March 12, in response to the NRC request, the Nevada Operations Office of the ERDA provided personnel and equipment from the following ERDA contractors: Reynolds Electrical and Engineering Company (REECo), EG&G, Inc., and Lawrence Livermore Laboratory (LLL). REECo personnel immediately began intensive alpha surveys at selected locations previously identified by the EPA survey as containing multiple radium-dial gauges or other externally contaminated materials. Their survey (at the request of the owner) also included a house suspected of containing plywood from the NECO site. A thorough search of all areas of plywood construction at the house failed to locate any radioactive contamination. The alpha surveys in the Beatty area continued through Sunday, March 14, 1976.

Also on March 12, the LLL equipment was used to make *in situ* spectra measurements of the concrete slab inside the new courthouse. The spectra did not show any man-made nuclides greater than that expected from world-wide fallout. An additional *in situ* measurement was taken on a concrete slab inside the chicken coop previously monitored on March 2, 1976. Trace amounts of cobalt-60 were detected. Since plywood of undetermined origin had been used in enclosing the chicken coop, it could not be determined if the source of cobalt-60 was in the slab or in the plywood. In any case, the barely detectable radiation levels presented no significant health hazard. LLL participation in the Beatty area continued through Sunday, March 14.

EG&G participation in the field effort included aerial (visual and radiometric) surveys by helicopter. Additionally, a mobile gamma scanner drove all the streets of Beatty, checking for any areas of increased levels of gamma radioactivity and also assisted in the gamma search at outlying residences and ranches. EG&G participation was concluded on March 12. Reports of findings by each of the ERDA contractor groups will be through ERDA.

By Sunday evening, March 14, 1976, the vast majority of all residences, ranches, and businesses in Beatty and the immediate surrounding area had been surveyed. At this point it was decided to release all survey participants except one NRC staff member and the ORP--LVF coordinator. The coordinator continued to try to monitor locations where for one reason or another access to premises for monitoring had not previously been obtained.

On Monday, March 15, an alpha contaminated area of approximately two square feet was located at the City dump. A burned, radium-dial military wall clock had previously been found at this location. It was suggested to the acting NECO site manager that a sign of some type be placed in a prominent location at the dump advising dump users of the potential hazards associated with burning radioactive materials. It was also suggested that an attempt be made to remove the contaminated items and soil. On Tuesday, March 16, and Friday and Saturday, March 19 and 20, final surveys were completed by the EPA/ORP coordinator of all but seven known locations in the Beatty area. At these locations efforts to contact residents to gain access to premises had been unsuccessful. On Saturday evening, March 20, a detailed description of the seven remaining locations to be surveyed were left with the acting NECO site manager for followup by the NECO site radiological safety officer. A letter was also left at each of the seven locations directing the resident to contact the Deputy Sheriff to obtain a survey of the premises.

On March 18, 1976, at the request of the State radiological health supervisor, the ORP--LVF director and the ORP coordinator traveled to Pahrump, Nevada, (approximately 60 road miles west of Las Vegas) to assist the State, NRC, ERDA, and REECo in inspecting several residences belonging to former NECO employees.

A survey at two locations (outside only at one residence since the owner was not at home) by the EPA representatives did not locate any radioactive contamination, although two pairs of anti-contamination coveralls were found at one location. An ERDA team returned to this residence when the owner was at home and located some radioactive material inside the dwelling. This will be reported separately by ERDA. The survey at the third location identified four items containing radioactivity or having obviously come from the NECO site. These items consisted of a glass optical lens (100 μR/hr. gamma), a set of socket tools marked "CTR/RF" (no detectable contamination but the marking was consistent with other tools shipped to NECO for burial), a large Navy floating-card compass with a radium dial (250 μR/hr. gamma), and a U.S. Army pocket compass containing tritium. No surface alpha contamination was identified on any item.

During a visit to the Amargosa farm area (approximately 85 miles north of Las Vegas) later that day, the EPA team identified two Bennett containers which were welded end to end to form a cylindrical enclosure. Presumably, the larger tank was to be used as a septic tank. In addition, two containers were tentatively identified (at a distance) at a ranch being used probably for either stock or irrigation water.

Wednesday afternoon, March 24, at the request of an ex-NECO employee living in Las Vegas, Nevada, the ORP coordinator surveyed personal tools that had been used at the NECO site by the ex-employee during his employment there. This request was made through the State radiological health officer. The survey located an uncontaminated (but of NECO origin) tool and a personally owned compressed air blowgun, slightly contaminated on the exterior (30 μR/hr. gamma). The contamination was later identified as cobalt-60. Both items were voluntarily surrendered for proper disposition.

By Friday, March 26, NECO had advised that all items identified by the survey had been picked up by NECO personnel and returned to the NECO burial site with the exception of some contaminated tarpaulins (at a residence where the owners had not been found at home). On April 2, NECO advised that the contaminated tarpaulins had been picked up and returned to the burial site.

## DISCUSSION

Although the search showed that radioactive items intended for burial at the site were widespread throughout the Beatty area, the actual external radiation exposure to individuals is believed to have been small since external beta-gamma exposure rates were generally low except when in actual close contact with items such as clocks, compasses, or tools. Exposures to individuals from such items would be expected to be of limited duration and primarily to the extremities instead of to the whole body. This should also be true for the localized contamination found on a piece of carpet.

Some materials did have surface radioactivity which would easily be transferred to the hands by handling and subsequently ingested. Fortunately, most of these items were of such a nature (i.e., centrifuge, balance, weights, sample mixer) that handling should have been infrequent. Persons believed to have had the highest probability of contact with these materials are being given bioassays and/or whole body counts. These results will be reported separately but would be expected to show little, if any, internal body deposition of radionuclides associated with the radioactive items.

Field measurements of airborne radionuclides were not made during the survey. However, based on the types of radioactive items encountered, significant airborne concentrations would not be expected. The potential for inhalation is believed minimal.

Laboratory measurements made on two radium-dial clocks and a radium-dial wrist compass indicated that a typical dwelling containing one of these items would not be expected to have significantly elevated levels of airborne radon-222 or its progeny (Appendix III).

Two dwellings were found where metal shipping (Bennett) containers were used for water storage. At one location, water was used as a potable water source. At the second location, water was being used for showers and for watering pets, but was not used as a source of drinking water. Water samples from these two tanks showed no detectable levels of plutonium, tritium, or gamma-emitting radionuclides. Residents from these locations are being whole-body counted.

Concrete pours containing detectable levels of radionuclides were found at four locations. Elevated gamma radiation levels were found only at location 26 (see Appendix I). There may have been additional pours since there was some indication that concrete sewer manhole collars may have been poured using the contaminated concrete truck. Several collars were spot-checked with several meters, but the measurements did not conclusively show above-background levels. A concrete sample from location 30 was treated in the EMSL--LV laboratory to remove chemically-bound water. The water was then analyzed and found to contain about 11 nanocuries per liter of tritium. Although this level is, perhaps, 10-20 times background, it would not be a significant source of exposure because of the chemical binding of the tritium in the concrete.

In all, ORP--LVF provided about 41 man-days of field effort to the field survey. Approximately 15 man-days were expended in laboratory analysis and report preparation. EMSL--LV provided approximately 12 man-days of field effort to the field study. EPA/Region IX provided approximately four man-days of field effort.

## APPENDIX I

### Location and Identification of Radioactive Items Found During Beatty, Nevada, Survey--March 1976

Location 1:

Items located: vegetation and soil samples collected 25 yards south of the NECO site boundary.

Isotopes identified: cobalt-58, cobalt-60, and manganese-54[1] in soil and vegetation.

Location 2:

Items located: aircraft instruments with radium dials and a radium-dial military wall clock.

Location 3:

Items located: burned radium-dial military wall clock with resultant surface soil contamination (approximately 2 ft. radius).

Alpha activity: 50,000 cpm[2] in soil.

Location 4:

Items located: Bennett container (serial No. 255). Gamma-emitting point sources in soil about 12 inches from lip of the container. Container was not found to be contaminated.

Exposure rate: 350 μR/hr.[3,4] gamma and 50 μR/hr.[3] gamma on point sources in soil.

Beta activity: 3,780 dpm beta[2] on 350 μR/hr. soil sample.

Isotopes identified: cobalt-60, antimony-125, chromium-51, silver-110m, and silver-108m in soil sources.[2]

Location 5:

Items located: many radium-dial instruments (pressure gauges, tachometers, temperature gauges, etc.), radium-dial military wall clock, aircraft door handle with radium buttons, three sheets of 4'x8'x1/16" Magne-Thor (presumably

magnesium-thorium alloy), a large rubber tire (approximately 2 ft. thick x 5 ft. in diameter), plywood chicken coop door, centerless grinder (dry sample mixer), plywood pickup truck toolbox and aircraft tool.

Exposure rate: 150 mrad/hr.[2,4] beta plus gamma on aircraft tool.

Alpha activity: 100,000 cpm on pickup toolbox.[2]

Isotopes identified: radium-226 on pickup toolbox,[2] and uranium-238/235 on centerless grinder.[5]

Location 6:

Items located: Bennett container (used as a water reservoir for showers and pets), triple beam laboratory balance, and brass balance weights.

Isotopes identified: plutonium-239 on balance[1] and one weight;[5] cesium-137 on another weight;[5] cobalt-60, cesium-134, and europium-155 on swipe of balance and weights.[6]

Note: Analysis of water sample from Bennett container indicated no plutonium, tritium, or gamma-emitting radionuclides above natural background.[1] Swipes of container were negative for alpha and beta emitters.[2] On-site gamma analysis of container by LLL was negative.[6]

Location 7:

Item located: radium-dial military wall clock.

Location 8:

Items located: centrifuge, numerous radium-dial military wall clocks, numerous radium-dial gauges, two lead bricks, several metal sample containers, mixer, radium check source, several floating-card ship compasses, two hydraulic actuators, and two explosion-proof metal cans.

Exposure rate: 20 mrad/hr.[2] beta plus gamma on lead bricks.

Isotopes identified: carbon-14 on centrifuge,[2] radium-226[6] on lead bricks, cobalt-60 on centrifuge,[6] and uranium-238/235 on mixer.[5]

Location 9:

Items located: several radium-tipped switches.

Location 10:

Items located: Bennett container (used as potable water reservoir) and a radium-dial military wall clock.

Note: Analysis of water sample from Bennett container indicated no plutonium, tritium, or gamma-emitting radionuclides above natural background.[1] Swipes of container were negative for alpha and beta emitters.[2] On-site gamma analysis of container by LLL was negative.[6]

Location 11:

Items located: 4'x4'x8' plywood shipping box and a military night scope.

Exposure rate: 200 μR/hr.[3] gamma point source in the corner of the shipping box.

Location 12:

Item located: radium-dial military wall clock.

Location 13:

Items located: wooden bench (one corner contaminated) and a radium-dial compass.

Exposure rate: 20 mrad/hr.[2] beta plus gamma on corner of bench.

Location 14:

Item located: radium-dial military wall clock.

Location 15:

Item located: radium-dial compass.

Location 16:

Item located: radium-dial compass.

Location 17:

Item located: sheet of plywood on storage shed with small area of contamination.

Exposure rate: 100 μR/hr.[3] gamma.

Alpha activity: 9,000 cpm.[3]

Isotope identified: uranium-238/235[2],[5]

Location 18:

Items located: radium-dial military wall clock, taps and dies and other miscellaneous tools and radium-dial gauges.

Location 19:

Item located: trace of cobalt-60[6] detected in the interior of chicken coop (source not identified but probably cement slab or plywood enclosure or contribution from both).

Location 20:

Items located: two radium-dial military wall clocks.

Location 21:

Item located: radium-dial military wall clock.

Location 22:

Items located: six radium-dial gauges and a radium-dial compass.

Location 23:

Item located: concrete base for clothesline pole.

Isotopes identified: cobalt-58, cobalt-60, and manganese-54.[1]

Location 24:

Item located: radium-dial military wall clock.

Location 25:

Items located: plastic bag of tools with magenta and white stickers.

Exposure rate: 350 μR/hr.[3] gamma.

Location 26:

Item located: concrete slab with three point source "hot" spots (first contaminated item to be located and removed to NECO site).

Exposure rate: 45 mrad/hr.[3] beta plus gamma contact.

Isotopes identified: cobalt-58, cobalt-60, and manganese-54 from concrete samples.[1] "Hot" spot was primarily cobalt-60.[1]

Location 27:

Items located: two radium-dial military wall clocks.

Location 28:

Item located: radium-dial military wall clock.

Location 29:

Item located: rug in living quarters.

Exposure rate: 110 mrad/hr.[2] beta plus gamma over very small area.

Isotope identified: radim-226.[6]

Location 30:

Item located: concrete slab.

Exposure rate: 4-6 μR/hr.[3] gamma above background (background was approximately 9-10 μR/hr.).

Isotopes identified: cobalt-58, cobalt-60, manganese-54, and tritium in concrete samples.[1]

Location 31:

Items located: 3' high x 4' wide x 8' long stack of plywood (individual sheets were not surveyed) and radium-tipped switches.

Exposure rate: 3 mrad/hr.[2] beta plus gamma on plywood.

Location 32:

Items located: acetylene welding tank gauges and several radium-dial gauges.

Location 33:

Item located: radium-dial military wall clock.

Location 34:

Items located: five Bennett containers (four welded together and used as sand storage; no contamination identified on containers), several radium-dial gauges, and a radium-dial compass.

Location 35:

Item located: two-pound coffee can containing green crystals (may be radium salts or ore concentrate)--not NECO origin but removed at owner's request.

Exposure rate: 3 mR/hr.[3] gamma at surface of can.

Location 36:

Items located: pump body and a radium-dial compass.

Exposure rate: 500 μR/hr.[3] gamma on the pump body.

Beta activity: 19 dpm beta[2] on swipe from the pump body.

Location 37:

Items located: tools, radium-dial military wall clock, small radium-dial instruments, gauges, stainless steel bolts, contaminated areas on two sheets of plywood on a storage shed, and a small area (approximately 3 ft. radius) of contaminated soil near wash. (The source of contamination was later identified as a contaminated rag approximately 2 ft. beneath the soil surface. The rag was possibly washed from upstream, deposited, and covered with flash flood sediment.)

Isotopes identified: cobalt-60 in soil.[6]

Location 38:

Items located: 7 radium-dial military wall clocks, 8 electrical fuse or circuit breaker boxes, and many small and varied radium-dial gauges.

Location 39:

Items located: a 1'x2'x3' yellow military chest, many yellow tarpaulins, a radium-dial military wall clock, many small radium-dial gauges, a large electrical panel (2'x5'), and a radium-dial tensiometer.

Note: The tensiometer was apparently leaking since external alpha contamination was identified.

Location 40:

Items located: a reel of cable, 15-20 sealed 6 in. diameter x 30 ft. long pipes from the AEC Rulison project containing smaller tritium contaminated piping, one 6 in. pipe from the Rulison project containing similar material but with one end open (originally sealed also), 2 1/2 Bennett containers (not contaminated), and radium-dial compasses.

Location 41:

Items located: approximately 24 radium-tipped switches, three radium-dial military wall clocks, two 6"x12"x18" stainless steel boxes, electric hoist, "A" frame, 9 1/2 Bennett containers (not contaminated), two 8'x2" pipes, plywood sheet used as window cover on shed (outdoor beer bar), surveying transit with radium lettering, 10 electric motors (another 10 to 20 similar motors were monitored on the motor exterior with negative results), sump pump with approximately 100 ft. of plastic hose, 2"x12"x15' boards used as floor of horse trailer, wooden pallet (containing insecticides), and two aircraft instruments with radium dials.

Exposure rate: 15 mrad/hr.[2] beta plus gamma on 2"x12"x15' planks.

Isotope identified: plutonium-238 on electric hoist.[5]

Location 42:

Items located: two 2'x6'x6' metal shipping containers used as stock watering troughs, 1 1/2 Bennett containers (1/2 container used as water reservoir (container not contaminated)), four 30-gallon shipping containers (not contaminated), and an uncontaminated wrench with a magenta band.

Exposure rate: 0.4 mrad/hr.[3] beta plus gamma on 2'x6'x6' container.

Isotope identified: cobalt-60 from swipe on water troughs.[6]

Location 43:

Items located: tools with magenta markings, miscellaneous radium dial gauges, military radio, numerous U.S. Navy electric motors, interior walls and a door and frame from a radioactive hot laboratory.

Isotopes identified: cobalt-60 and cesium-137.[7]

Location 44:

Item located: radium-dial military wall clock.

Location 45:

Items located: several radium-tipped switches.

Notes:

1. EPA (EMSL--LV) analysis.

2. Preliminary measurements made by the REECo monitoring team or the REECo laboratory analysis. For measurement verification and a description of the instrumentation, see the REECo final report.

3. Field measurements made by EPA personnel using a Baird-Atomic NE-148A gamma scintillator and/or an Eberline Instrument Company PAC-1SA alpha scintillator (59 $cm^2$ surface area). All measurements are surface contact.

4. Gamma readings reported as μR/hr. or mR/hr. Gamma plus beta readings reported as mrad/hr.

5. Idaho Nuclear Engineering Laboratory analysis from swipe or sample supplied by NRC personnel.

6. Analysis on site by LLL solid state (Ge-Li) gamma detection equipment. See LLL final report for measurement verification and description of instrumentation.

7. Identification by EG&G mobile van. See LLL final report for measurement verification and description of instrumentation.

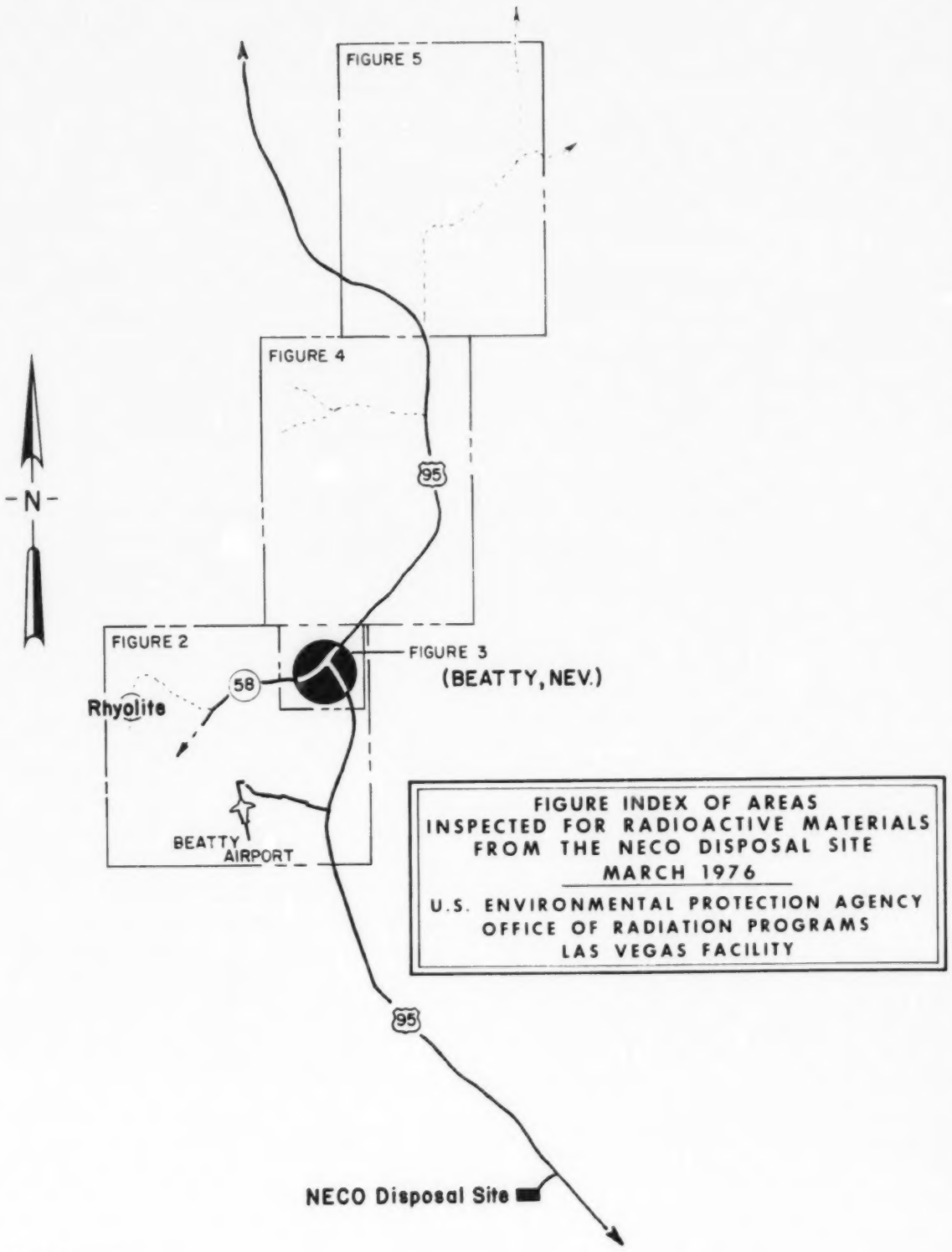


FIGURE 5
FIGURE 4
95
N
FIGURE 2
FIGURE 3
(BEATTY, NEV.)
58
Rhyolite
BEATTY AIRPORT
95
NECO Disposal Site
FIGURE INDEX OF AREAS
INSPECTED FOR RADIOACTIVE MATERIALS
FROM THE NECO DISPOSAL SITE
MARCH 1976
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS
LAS VEGAS FACILITY

figure 1

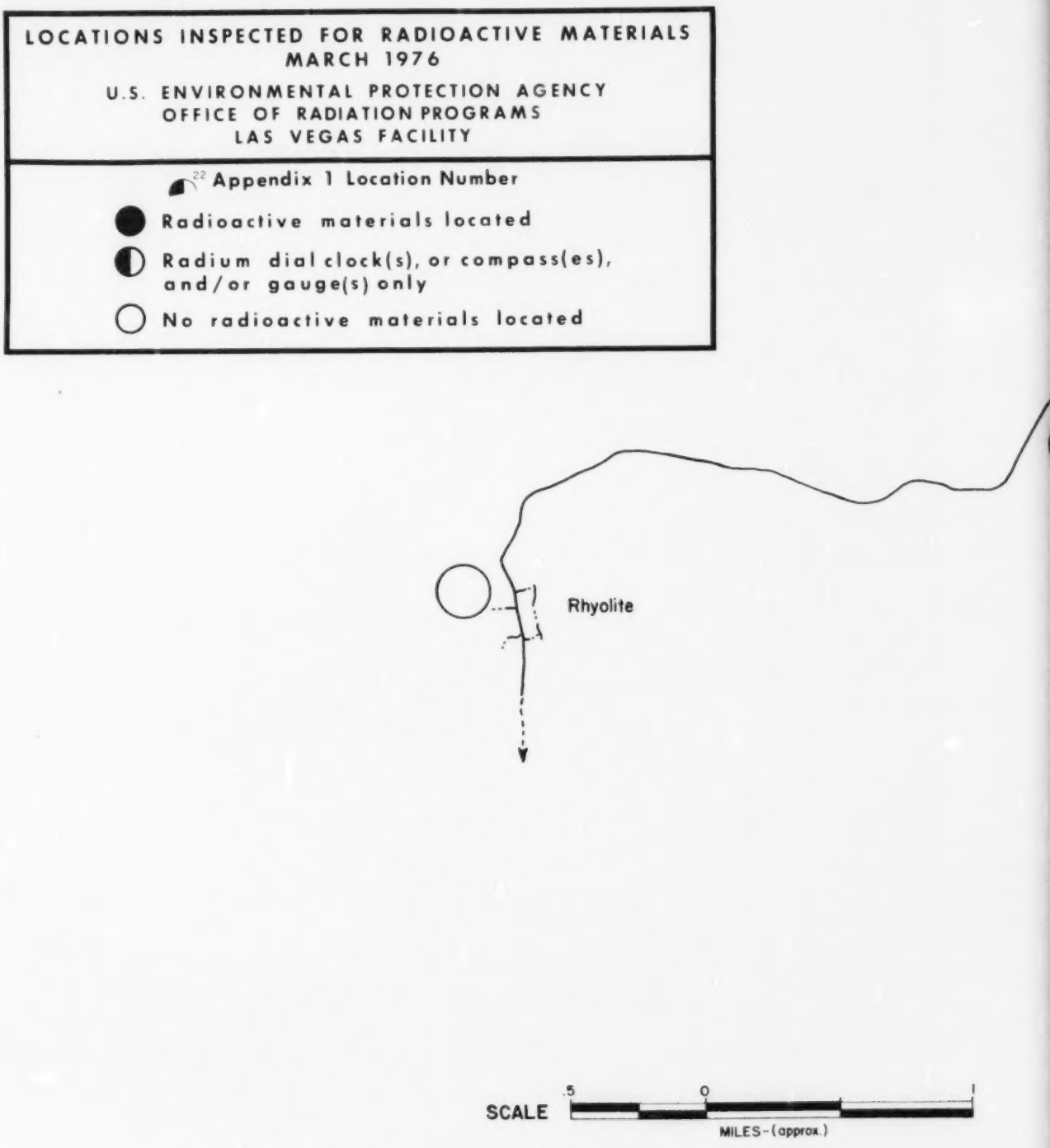
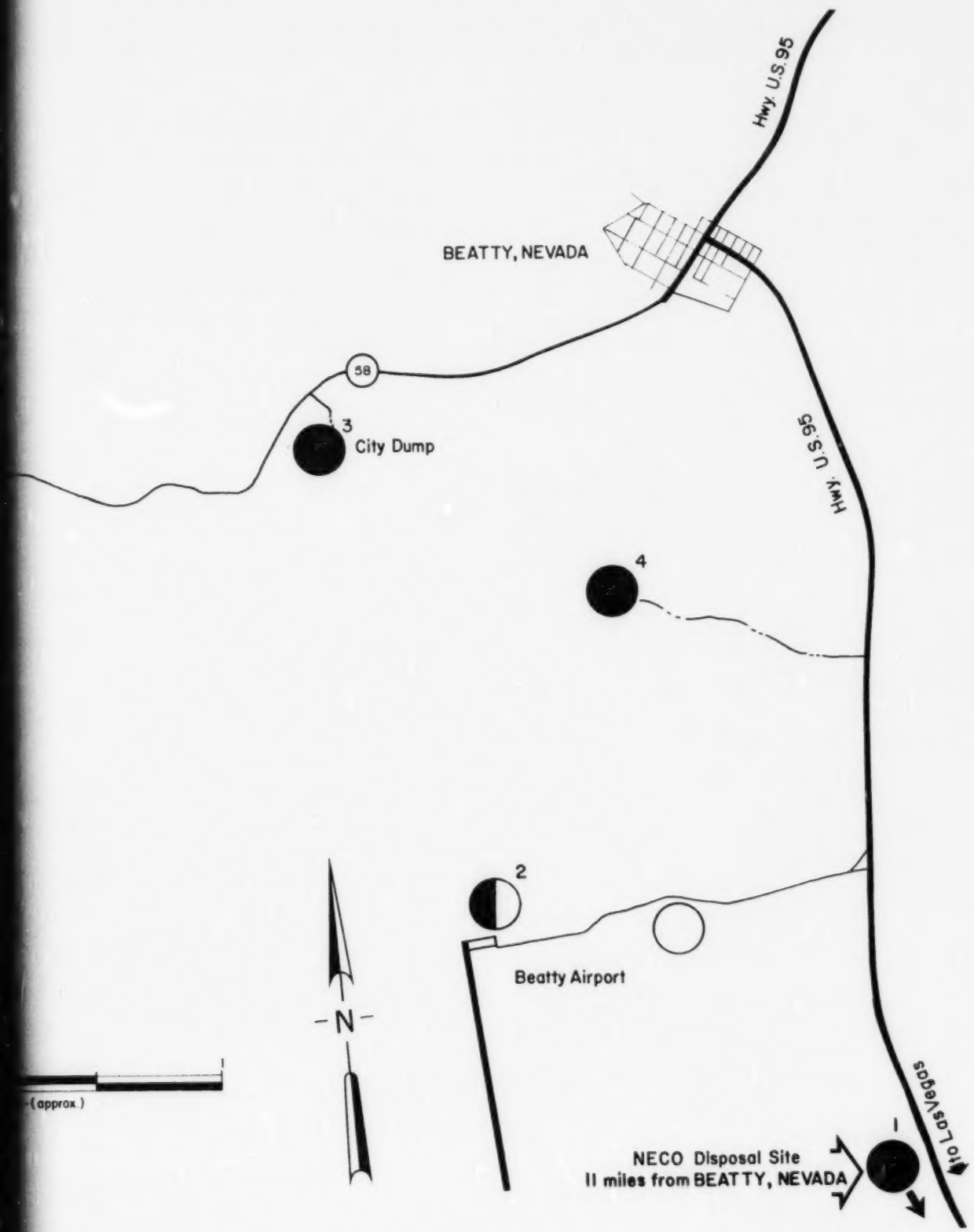

LOCATIONS INSPECTED FOR RADIOACTIVE MATERIALS
MARCH 1976
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS
LAS VEGAS FACILITY
22 Appendix 1 Location Number
Radioactive materials located
Radium dial clock(s), or compass(es), and/or gauge(s) only
No radioactive materials located
Rhyolite
SCALE
.5
0
1
MILES-(approx.)

figure 2


Hwy. U.S.95
BEATTY, NEVADA
58
3
City Dump
HWY. U.S.95
4
2
Beatty Airport
N
(approx.)
to Las Vegas
1
NECO Disposal Site
11 miles from BEATTY, NEVADA

RADIOACTIVE MATERIALS LOCATED IN BEATTY, NEVADA
MARCH 1976
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS
LAS VEGAS FACILITY
Radioactive materials located
Radium dial clock(s), or compass(es), and/or gauge(s) only
6
8
7
Hill
Irving
to Rhyolite
58
5
500'
0
500'
1000'
Feet (Approx.)

figure 3

10 (approx .5 miles)
11
9
8
7
Hill
Second
Third
Fourth
First
Beach
Irving
Ward
Reibel
Montgomery
Main
Watson
Lewis
McDonald
Amargosa
Valley
Cedar
AMARGOSA RIVER WASH
Hwy. U.S. 95
to TONOPAH
Hwy. U.S. 95
to LAS VEGAS
AMARGOSA RIVER WASH
58
N
500'
1000'
(Approx.)

LOCATIONS INSPECTED FOR RADIOACTIVE MATERIALS
MARCH 1976

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS
LAS VEGAS FACILITY

22 Appendix 1 Location Number

Radioactive materials located

Radium dial clock(s), or compass(es), and/or gauge(s) only

No radioactive materials located

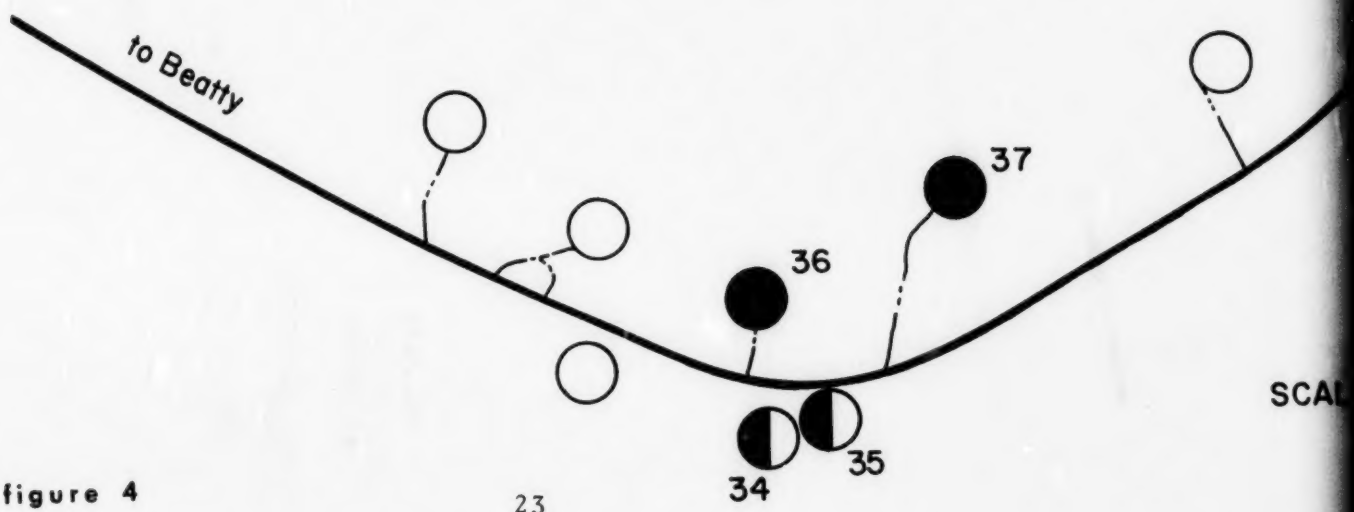
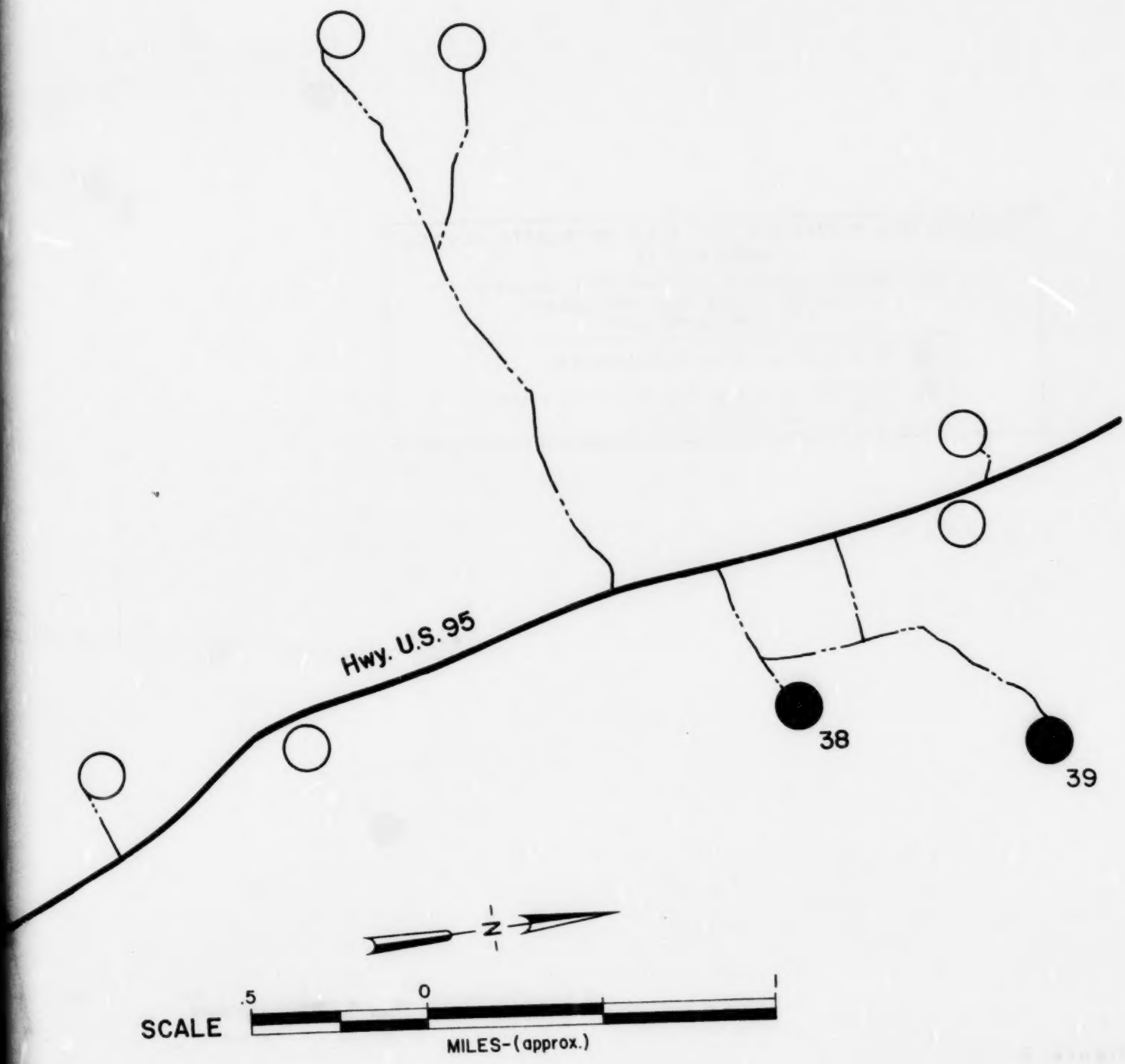



figure 4


Hwy. U.S. 95
38
39
N
SCALE
.5
0
1
MILES-(approx.)

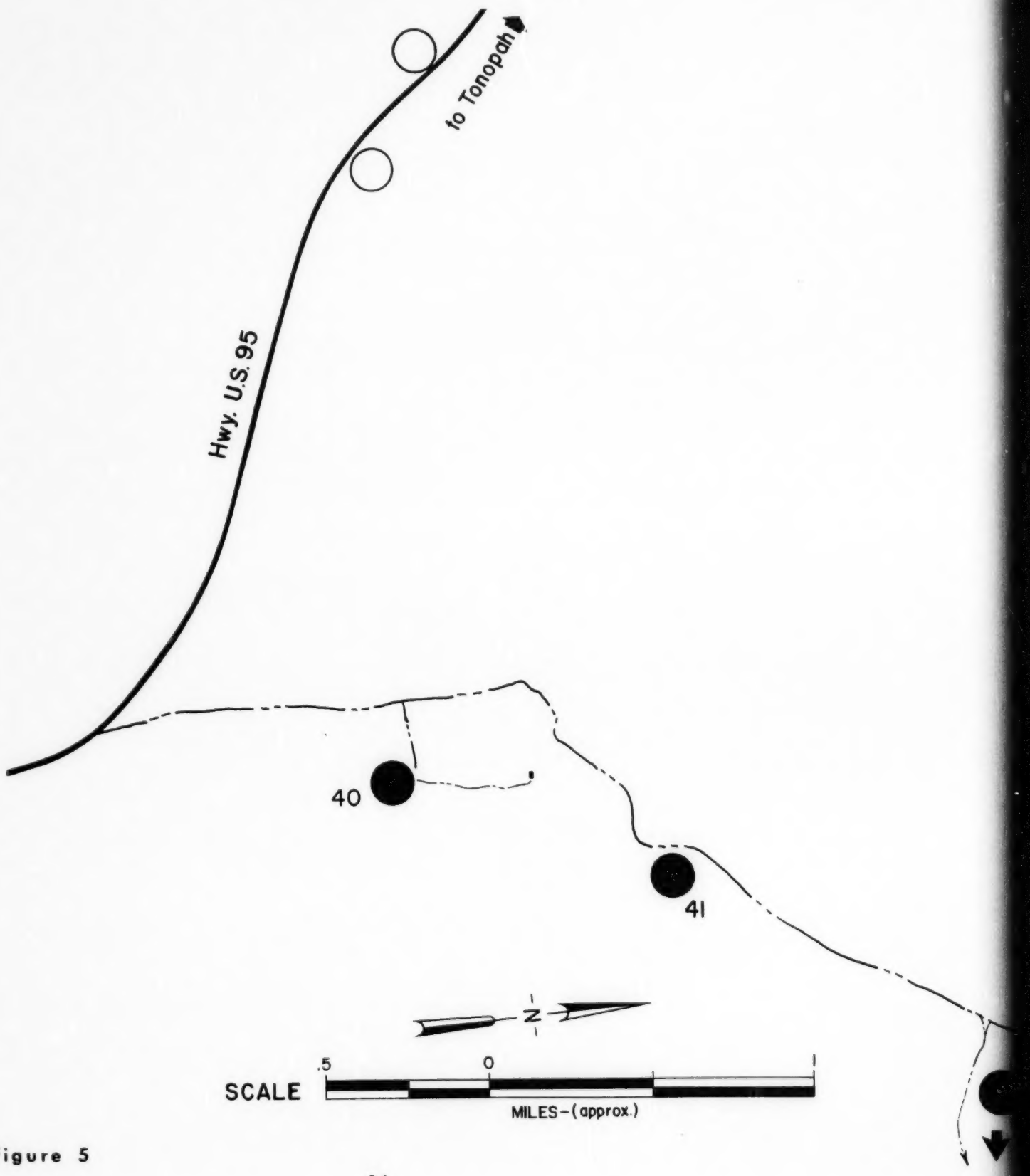



figure 5

LOCATIONS INSPECTED FOR RADIOACTIVE MATERIALS
MARCH 1976

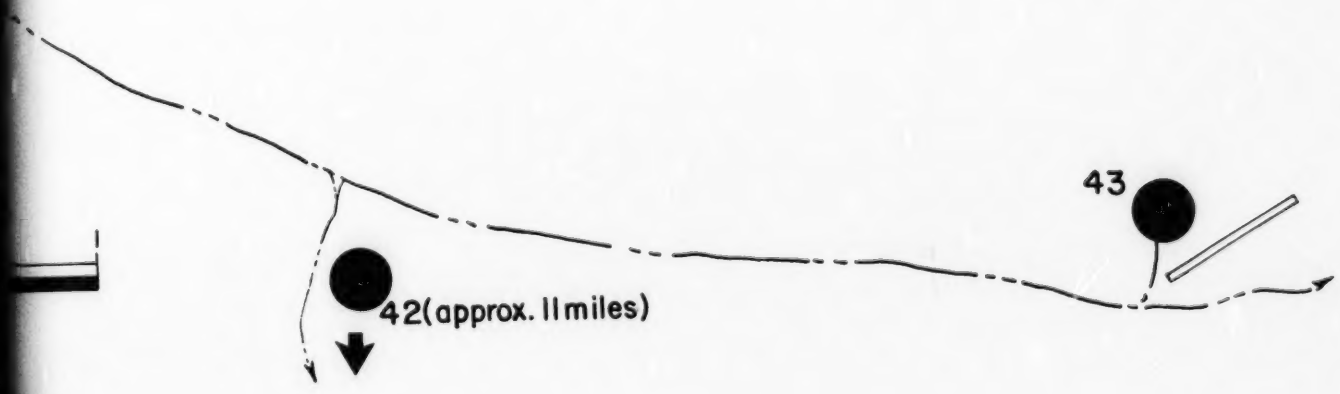
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS
LAS VEGAS FACILITY

22 Appendix 1 Location Number

● Radioactive materials located

◐ Radium dial clock(s), or compass(es), and/or gauge(s) only

○ No radioactive materials located



# APPENDIX II

Selected Photographs of Items
Located During Beatty Survey

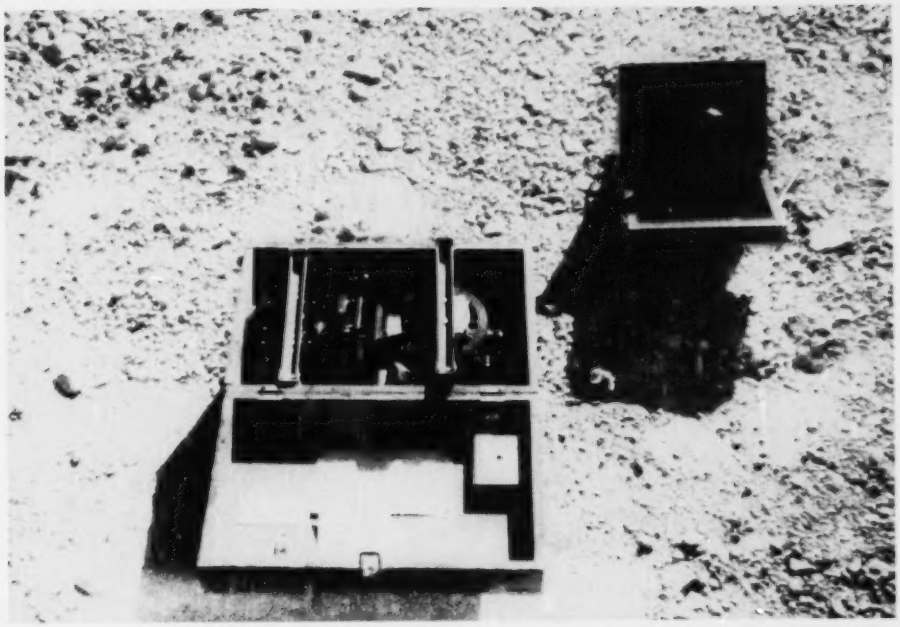


Figure 1. Military Clock (Location 5) and Military Transit (Location 41). (Photograph taken after items were returned to burial site.)

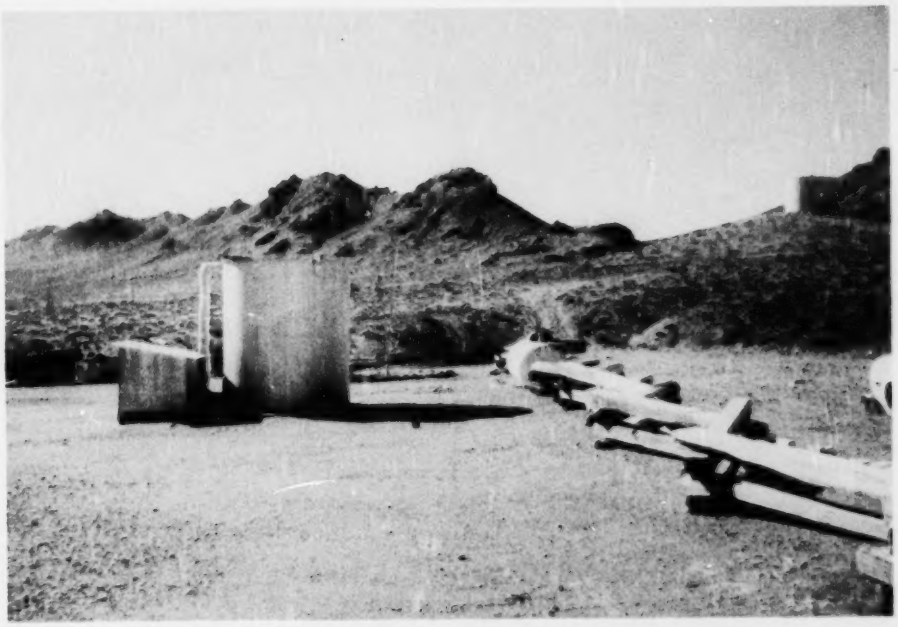


Figure 2. Bennett container in use for home water storage (Location 6).

Figure 3. Electric mixer and centrifuge (Location 8).

Figure 4. Miscellaneous military clocks and electrical fuse boxes (Location 38).

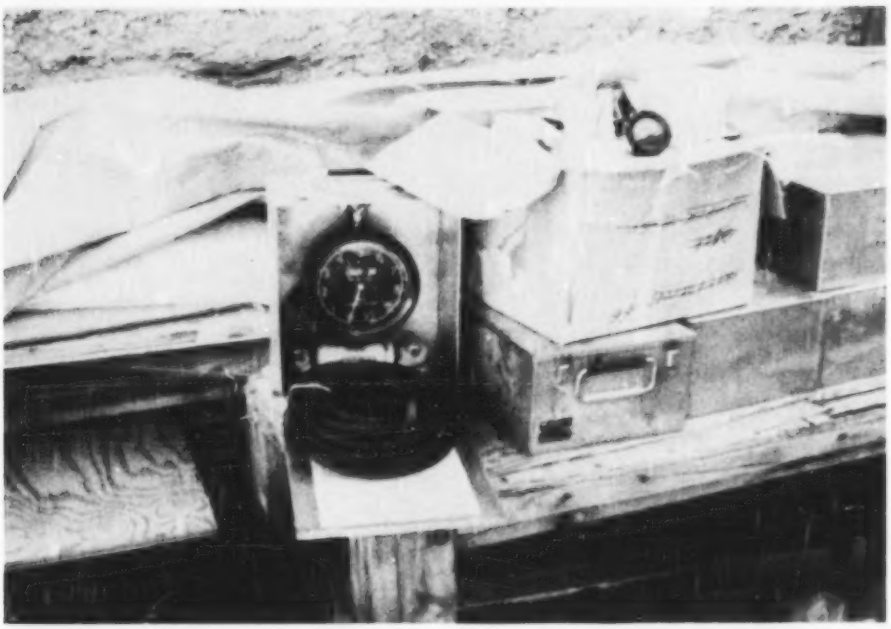


Figure 5. Tensiometers (Location 39). (Photograph taken after items were returned to burial site.)

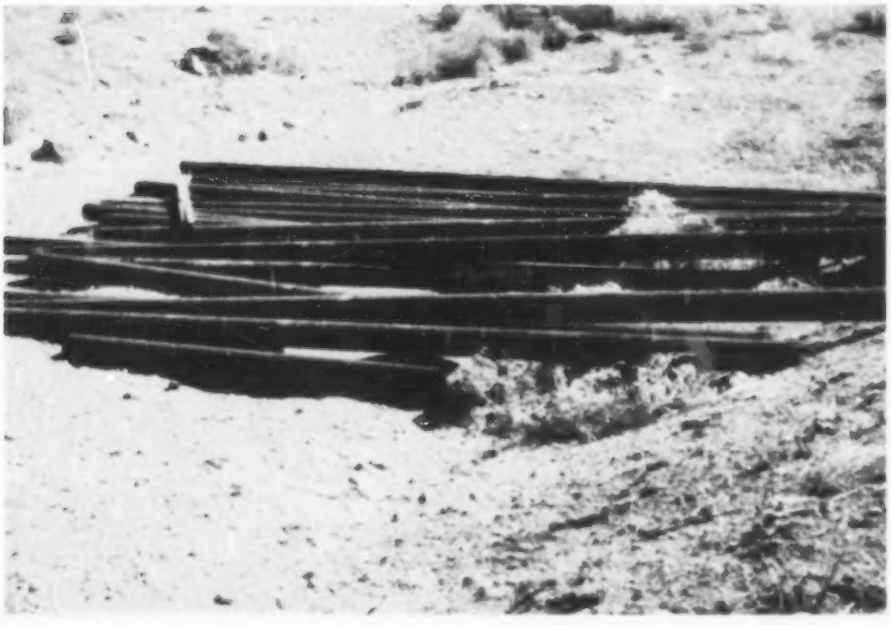


Figure 6. Rulison Pipe (Location 40).

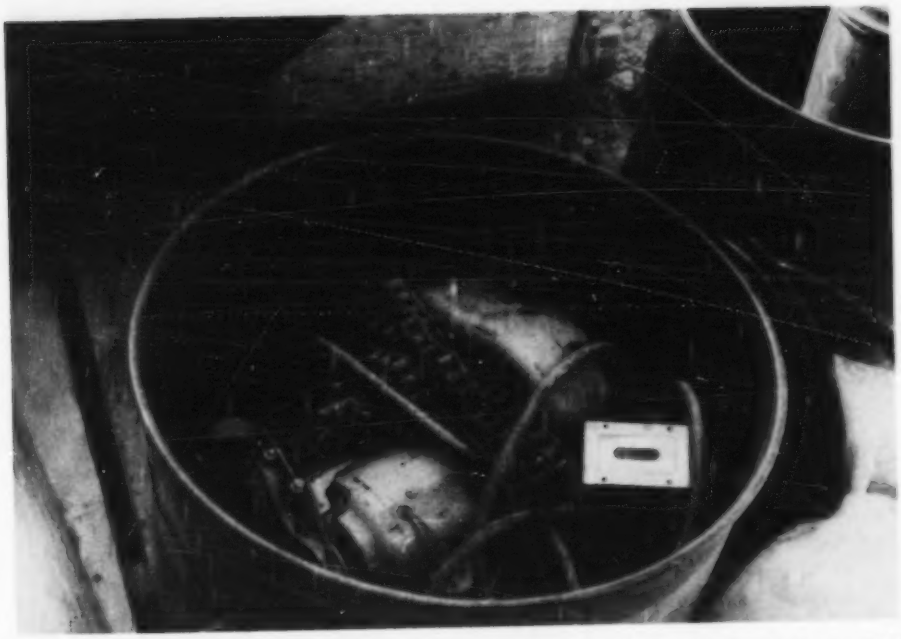


Figure 7. Contaminated electric hoist (Location 41). (Photograph taken after item was returned to burial site.)

Figure 8. Empty Bennett container (Location 41).

Figure 9. Empty Bennett containers and other miscellaneous materials (Location 41). (Photograph taken after items were returned to burial site.)

Figure 10. Contaminated metal shipping container (foreground) in use as stock watering trough and one-half Bennett container (Location 42).

Figure 11. Radioactivity laboratory wall panels (foreground)(Location 43). (Photograph taken after items were returned to burial site.)

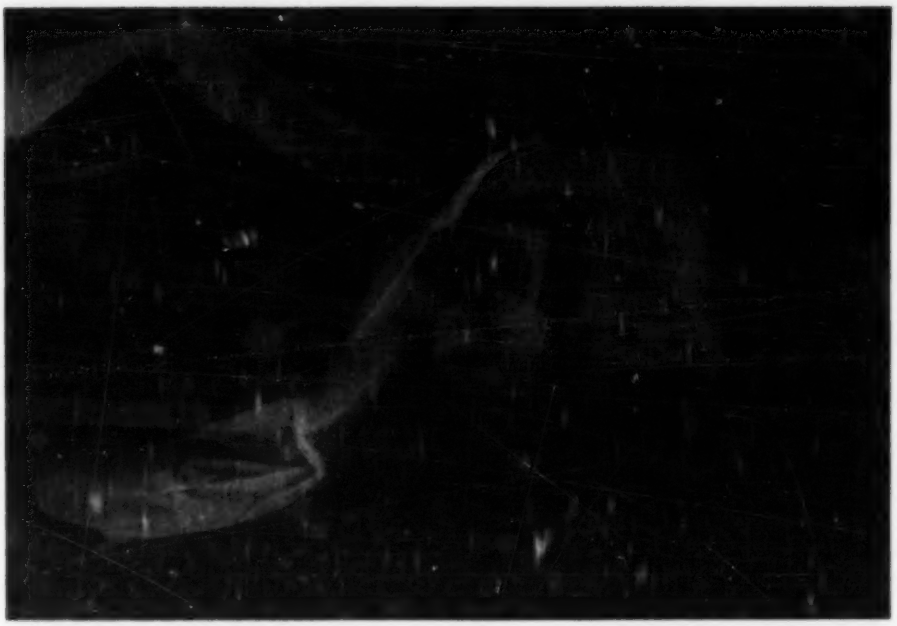


Figure 12. Electric motors and pumps (Location 43). (Photograph taken after items were returned to burial site.)

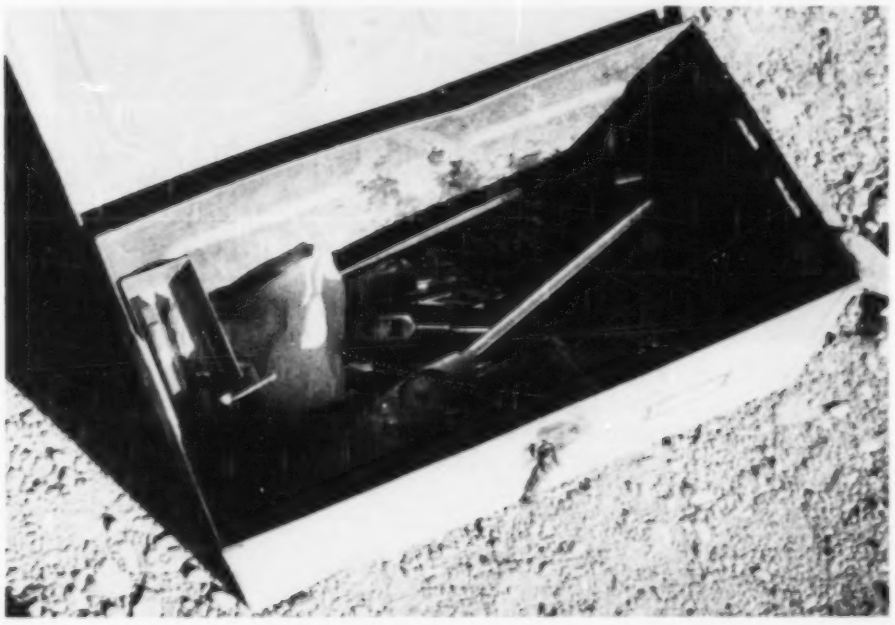


Figure 13. Miscellaneous contaminated tools (Location 43). (Photograph taken after items were returned to burial site.)

Figure 14. Navy floating-card compass (Pahrump).

Figure 15. Military clocks and compass. (See Appendix III) Photograph taken at LVF.

## APPENDIX III

### Radium-Dial Clocks and Compass

Because the primary thrust of the State concern was to identify and remove any items which might present real or potential health hazards and which obviously were intended for burial at the site, no large effort was expended to make comprehensive dose measurements on each individual item as it was identified. In any case, the large numbers of individual items found would have precluded such an effort. However, because a large number of radium-dial military clocks and compasses were recovered from homes, it appeared worthwhile to make separate dose measurements on some of these items. With State permission, a U.S. Army wall clock, a U.S. Navy wall clock, and a U.S. Army wrist compass were selected from those which had been returned to the burial site and taken to the ORP-LVF for further study. Exposure rate measurements were taken at the surface with an Eberline E-500B beta/gamma survey meter. Exposure rate measurements were also taken at one meter, two meters, and three meters with a Reuter-Stokes Model RSS-111 Pressurized Ionization Chamber. The instruments were individually placed in an environmental chamber and the rate of radon gas release measured by collecting filtered air samples in a scintillation cell followed by analysis of the scintillation cell. The results are as follows:

U.S. Navy Wall Clock:

This clock was black and measured 4 inches high and 7 inches in diameter. The markings were "Mark I, Deck Clock, U.S. Navy, 63544, 1943, Seth Thomas."

Using an E-500B survey meter, the maximum exposure rates at the clock glass cover face surface were 50 mrad/hr. beta plus gamma and 4 mR/hr. gamma. Using a pressurized ionization chamber (PIC), the gamma radiation levels at one meter, two meters, and three meters from the clock face were 8.5 µR/hr., 2.5 µR/hr., and 0.8 µR/hr. above a background of 9.5 µR/hr.

This clock releases radon-222 at a rate of about 0.14 picocuries per second (pCi/sec.). If the clock were used in a 1,000 square foot home with one air change per hour, the house would contain about $2.2 \times 10^{-3}$ picocuries per liter (pCi/l) above the naturally occurring background radon levels which would be expected to be on the order of 0.5 pCi/l. The clock would, therefore, result in an added exposure to the house resident

of, perhaps, one to several per cent of the natural radon background, depending on actual house or trailer home size, actual number of air changes, and how many hours per day the resident occupied the house.

U.S. Army Wall Clock:

This clock had a brass container approximately 5 1/4 inches in diameter by 2 1/2 inches high. The labeling on the clock read "Message Center, M1, Chelsea Clock Co., Boston, 446315."

The maximum E-500B contact readings on the clock glass cover above the face were 50 mrad/hr. beta plus gamma and 4 mR/hr. gamma. The PIC measurements at one meter, two meters, and three meters were 5.5 μR/hr, 2.0 μR/hr, and 1.0 μR/hr., respectively, above the 9.5 μR/hr. background. This clock releases radon at a rate of about 0.06 pCi/sec. or about one-half the level released by the Navy clock.

U.S. Army Wrist Compass:

This compass was in a green plastic body about 1 1/2 inches in diameter and had a green cloth wrist strap. The maximum E-500B contact readings on the compass with the cover closed were 9 mrad/hr. beta plus gamma and 2 mR/hr. gamma. With the cover open, the maximum readings were 35 mrad/hr. beta plus gamma and 2.5 mR/hr. gamma.

External gamma levels as measured with the PIC at one meter, two meters, and three meters were 0.9 μR/hr., 0.5 μR/hr., and 0.3 μR/hr., respectively, above the 9.5 μR/hr. background. Because of the low exposure rates, it is questionable whether the two and three meter values are truly above background. This compass releases radon at a rate of about 0.007 pCi/sec. or about 1/20 the rate of the Navy clock.

Discussion:

From the foregoing it would appear that the airborne radon levels (and consequently the radon progeny levels) resulting from having such an intact clock or compass in the home would not contribute significantly to the background levels. Although the actual radium content of these particular clocks and the compass is not known, some similar military clocks now being phased out of service contain about 10 microcuries (μCi) of radium-226. Wrist compasses still in military use contain 1 to 15 μCi of radium-226.

The PIC gamma exposure rate from the Navy wall clock relates to a radium-226 point source of roughly 10 μCi. The radon production rate from 10 μCi is about 20 pCi/sec. Thus, as expected, only a small fraction of the radon produced is being released from the clock dial and clock.

Damage to such an instrument would probably make more radon available in addition to making the radium parent radionuclide available for possible ingestion or for contamination of property and persons. As an example, a radium clock was found to have been burned at the Beatty dump during the survey. As a result of the fire, a two-foot diameter circle was found to be contaminated with elevated radium-226 levels.

The gamma radiation exposure levels at one meter from the Navy clock are approximately equivalent to background radiation levels. However, since it is unlikely that anyone would remain within one meter of the clock for any extended period of time, the external exposures to such sources should be some small fraction of the existing gamma radiation background.

## APPENDIX IV

### Portable Survey Instruments Used in Beatty, Nevada, Survey

Baird-Atomic NE-148A Gamma Scintillator:

This scintillator is an extremely sensitive, portable gamma detecting instrument capable of detecting a 5 μC radium-226 source at about 6 feet in air. The six-foot measurement is approximately 2 μR/hr. above background, when background is approximately 4 μR/hr. It was used as the principal detector in the gamma search. Three ranges provide measurements to 3 mR/hr., with the lowest range 0-30 μR/hr. The detector is a sodium iodide crystal scintillator. Response time of the electronics is quite rapid, making the instrument an extremely good "fast search" gamma detector. A cesium-137 standard was used to calibrate the instrument.

Eberline Instrument Corp. PAC-1SA Alpha Scintillator:

The PAC-1SA is a scintillator with an active area of 59 $cm^2$ and is used for detecting alpha-emitting radionuclides. The crystal (silver activated zinc sulfide) has an aluminized Mylar window with a thickness of 1.5 $mg/cm^2$. The alpha scintillator was used to monitor suspect locations/items that had no detectable gamma levels. Four ranges provide measurements to $2 \times 10^6$ cpm. A plutonium-239 standard was used to calibrate the instrument.

Eberline Instrument Corp. E-500B Beta/Gamma Meter:

The E-500B employs two G-M tubes as the detector. A movable shield provides either gamma or gamma/beta readings. The effective wall thickness for the lower ranges in the gamma/beta mode is 30-40 $mg/cm^2$. Five ranges provide for measurements to 2 R/hr. The gamma response time is significantly slower than the NE-148A and the sensitivity is also correspondingly lower. For these reasons, the E-500B was used during the survey primarily when gamma radiation levels were encountered which were off-scale for the scintillator. A cesium-137 standard is used to calibrate the E-500B.

Reuter-Stokes RSS-111 Environmental Radiation Monitor:

The RSS-111 is an ultra-sensitive gamma exposure monitoring system designed to measure and record low-level exposure rates such as those due to fallout and natural background radiation. The RSS-111 can measure dosage increases of less than 1 mrad/year. The detector is a high pressure (25 atmosphere of ultra-pure argon) spherical (10 in. diameter) ionization chamber mounted directly to a solid state electrometer. Two ranges provide measurements from 0 μR/hr. to about 200 μR/hr.

Ludlum Measurements, Inc. Model 2200 Scaler:

A Ludlum model 2200 Scaler was used in conjunction with a photomultiplier tube (zinc sulfide crystal on photomultiplier tube face) mounted over a sliding drawer filter holder for use in counting alpha swipes.

Ludlum Measurements, Inc. Model 125 Gamma Scintillator:

The Ludlum Model 125 gamma scintillator is a hand-held instrument. It employs a 1"x1" NaI(tl) crystal coupled to a 1" diameter photomultiplier tube. This instrument is useful in the range of 0 to 3000 μR/hr. on three scales. It was calibrated with cesium-137.